AD-A141 430 AREA EQUIVALENT METHOD VISICALC (TRADE NAME)(U) FEDERAL AVIATION ADMINISTRATION WASHINGTON DC OFFICE OF ENVIRONMENT AND ENERGY T L CONNOR ET AL. FEB 84 1/1

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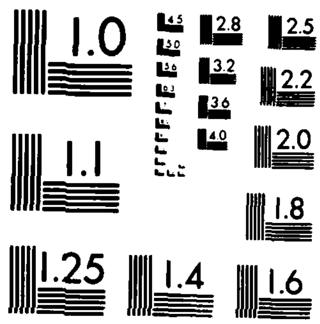


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

# AREA EQUIVALENT METHOD on VISICALC®


By: Thomas L. Connor
David N. Fortescue



February 1984
Report No. EE-84-8


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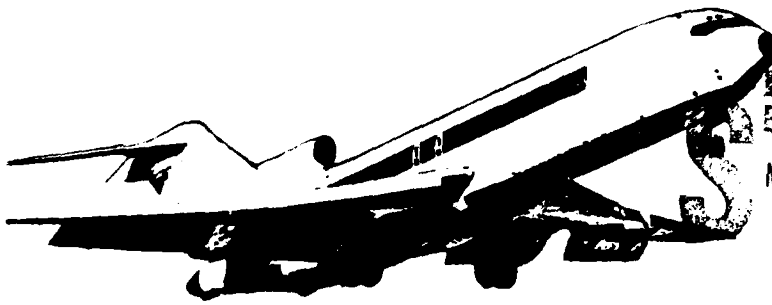
U.S. Department of Transportation
Federal Aviation Administration

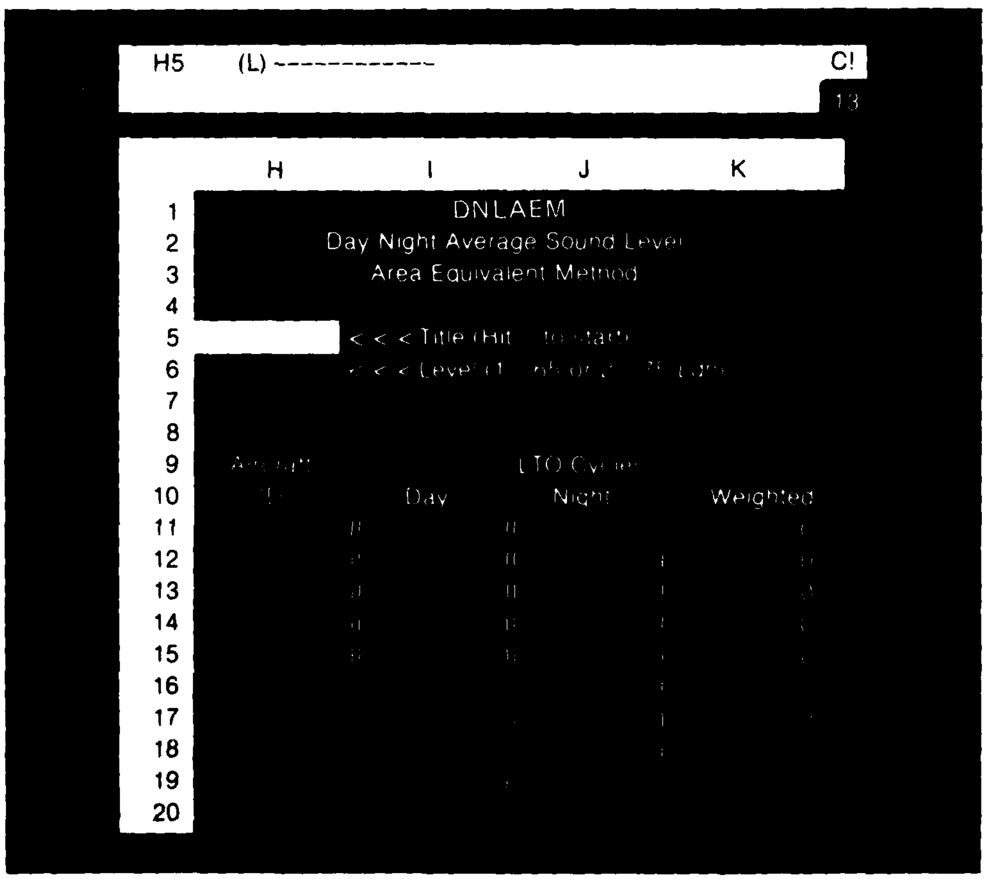












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NOTICE

**Technical Report Documentation Page**

| | | |
|---|---|---|
| 1. Report No. FAA-EE-84-8 | 2. Government Accession No. AD-A141430 | 3. Recipient's Catalog No. |
| 4. Title and Subtitle<br>Area Equivalent Method on VISICALC | | 5. Report Date February 1984 |
| | | 6. Performing Organization Code DOT/FAA |
| 7. Author(s)<br>Thomas L. Connor and David N. Fortescue | | 8. Performing Organization Report No. FAA-EE-84-8 |
| 9. Performing Organization Name and Address<br>Federal Aviation Administration<br>Office of Environment and Energy, AEE-120<br>800 Independence Ave., S.W.<br>Washington, DC 20591 | | 10. Work Unit No. (TRAIS) |
| | | 11. Contract or Grant No. |
| 12. Sponsoring Agency Name and Address | | 13. Type of Report and Period Covered<br>User's Guide |
| | | 14. Sponsoring Agency Code FAA/AEE |
| 15. Supplementary Notes | | |

16. Abstract


This document contains instructions to execute the Area Equivalent Method (AEM). The AEM requires the VISICALC software package and an Apple IIe personal computer or a calculator.

The Area Equivalent Method is a mathematical process to calculate Day Night Average Sound Level (DNL) contour area. The AEM is easy to use and is intended as a screening procedure to determine the need for an airport Environmental Impact Statement,(EIS).


| | |
|---|---|
| 17. Key Words<br>airport noise<br>computer model<br>Environmental Impact Statement<br>Day Night Average Sound Level | 18. Distribution Statement<br>A-X(AS)-2 A-1 |

| | | | |
|---|---|---|---|
| 19. Security Classif. (of this report) Unclassified | 20. Security Classif. (of this page) Unclassified | 21. No. of Pages 42 | 22. Price |

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

## ACKNOWLEDGEMENT

The Area Equivalent Method (AEM) was originally developed for the Environmental and Energy Programs Division, Office of Economic Analysis of the Civil Aeronautics Board (CAB). CAB wanted a quick way to determine airport Noise Exposure Forecast (NEF) contour area. The firm of J. Watson Noah Inc. created the original versions of AEM for computer, programmable calculator and pencil and paper (Reference 1). The AEM described within this report draws upon the techniques developed by J. Watson Noah Inc. with updated parameters to calculate Day Night Average Sound Level (DNL) contours.

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## 1.0 INTRODUCTION

The Area Equivalent Method is a mathematical procedure that provides the noise contour area of a specific airport given the types of aircraft and the number of operations for each aircraft. The noise contour area is a measure of the size of the land mass enclosed within a level of noise as produced by a given set of aircraft operations.

The noise contour metric is the Day Night Average Sound Level (DNL) which provides a single quantitative rating of a noise level over a 24-hour period. This rating involves a 10 decibel penalty to aircraft operations during nighttime (between 10pm and 7am) to account for the increased annoyance in the community.

The AEM produces contour areas (in square miles) for levels of 65 and 75 $L_{dn}$. The AEM is used to develop insights as to the noise impact of an airport on its surrounding communities, as well as the potential increase or decrease of noise resulting from a change in aircraft operations. The AEM is a useful screening tool in airport planning and development.

The following text will provide a more detailed explanation of the AEM as well as instructions for use of the AEM on the Apple® II plus or IIe using the VISICALC® software program. Instructions on the AEM calculator method are also included.

## 2.0 DESCRIPTION

According to FAA Order 1050.1C, "Policies and Procedures for Considering Environmental Impacts," an assessment must be made to determine the noise impact of a proposed airport action. This assessment compares the present noise impact on the environment with that of the proposed change. If the noise impact is significant then the FAA requires an Environmental Impact Statement (EIS). If the increase of noise impact on the community is not significant then the FAA prepares a Finding of No Significant Impact (FONSI), which briefly outlines the specifications of the change in airport operations for that particular airport.

An Environmental Impact Statement is a long and involved process which requires use of an airport noise computer model such as the Integrated Noise Model (INM). The INM is a complex and detailed procedure which determines the DNL noise contour area for a specific mix of aircraft, and plots the contour lines relative to runway configuration. The INM is a useful procedure for airport planners, airport operators and local governments in assessing the noise impact to the community around an airport. The INM offers the capability to analyze several operational controls beyond simply changing aircraft mix. The INM is the most appropriate tool for EIS, Airport Noise Control and Land Use Compatability (ANCLUC), Part 150 and other federally funded airport environmental studies.

The FAA informally adopted the Noise Screening Methodology, developed by the Civil Aeronautics Board (CAB), to decide whether the noise impact due to a change is significant. CAB promulgated this noise screening procedure in 14 CFR 312 Appendix I. It is commonly called the "CAB Procedure." CAB established a decision criterion of 17% increase in cumulative noise contour area. If the percentage difference due to the change is less than 17%, no further study is necessary. A 17% increase in cumulative noise contour area translates into a one decibel increase in the airport noise. The Area Equivalent Method (AEM) is an outgrowth of the CAB Procedure. The FAA applies the same decision criterion to AEM as the CAB does with the Noise Screening Methodology.

The AEM is a screening procedure used to simplify the assessment step in determining the need for an EIS. The purpose of the AEM is to show change in airport DNL noise contour area relative to a change in aircraft mix and number of operations. The AEM determines the DNL noise contour area in square miles for a mix and number of aircraft types. The basis of AEM is the equation which determines the DNL noise contour area as a function of the number of daily operations. The AEM applies parameters derived from INM output to determine a contour area for each aircraft. The AEM then develops a single equation, representing the specific mix and number of aircraft to produce the contour area for an airport. The contour area produced by the AEM approximates the contour area produced by the INM for a particular airport case.

## 3.0 DEVELOPMENT

The AEM determines the Day Night Average Sound Level (DNL) noise contour area (in square miles) for a specific case of aircraft operations, given the mix of aircraft types and the number of landing-takeoff cycles (LTOs) per aircraft. In order to create the AEM, aircraft specific parameters relating DNL noise contour area to LTOs were derived from INM output for 65 and 75 $L_{dn}$. These parameters, represented by the variables a ar b, are constants which produce the 65 or 75 $L_{dn}$ contour area due specific number of operations of an aircraft from the followir quation:

$$A = aN^b$$

The constant a is the noise contour area in square miles of a single LTO for an aircraft. The constant b is a scaling parameter which determines the change in contour area relative to a change in the number of effective LTOs for an aircraft. The noise contour area, A, is the result of applying the parameters a and b to N, the number of effective LTOs. The number of effective LTOs is the sum of the daytime LTOs and the nighttime LTOs of an aircraft. The nighttime LTOs are weighted by a multiple of 10 due to the added amount of annoyance to the community during the nighttime hours between 10pm and 7am.

The Integrated Noise Model (INM) Version 3.8 was used to produce aircraft noise contour areas for specific numbers of LTOs. INM was run for each of the 66 aircraft in the INM Version 3.8 data base. The parameters a and b are determined from the linear regression equation:

$$\log A = \log a + b \cdot \log N$$

Figure 3-1 illustrates the linear regression lines (solid lines) derived from this logorithmic equation for each DNL. The INM produced the contour areas as shown by the symbols □, △, ×, ▽ and ✱. The graph is based on a log - log relationship between the contour area in square miles and the number of LTOs of an aircraft at different values of DNL. The AEM, however, uses only the 65 and 75 $L_{dn}$ equations. Below each regression line on the graph is the equation of that line and a value for r. The equation is the linear transformation of the logorithmic equation with the parameters a and b and N:

$$A = aN^b$$

The correlation coefficient, r, indicates how well the regression line represents the relationship of contour area to a, b and N. An r value of 1.0000 indicates a perfect correlation between the equation and the calculated contour areas for that DNL. The parameters and correlation coefficients for all 66 aircraft in the INM Data Base #8 are given in Table 3-1.

The equation at the top of Figure 3-1 is the multiple regression equation for the aircraft. The dashed lines illustrate this multi-variate relationship. The equation involves a third parameter, c, which is a scaling parameter for a change in $L_{dn}$ relative to a change in contour area:

$$A = aN^b \cdot L_{dn}{}^c$$

The multiple regression coefficient r, shown below the multiple regression equation, represents the correlation of the multilinear equation to the contour areas.

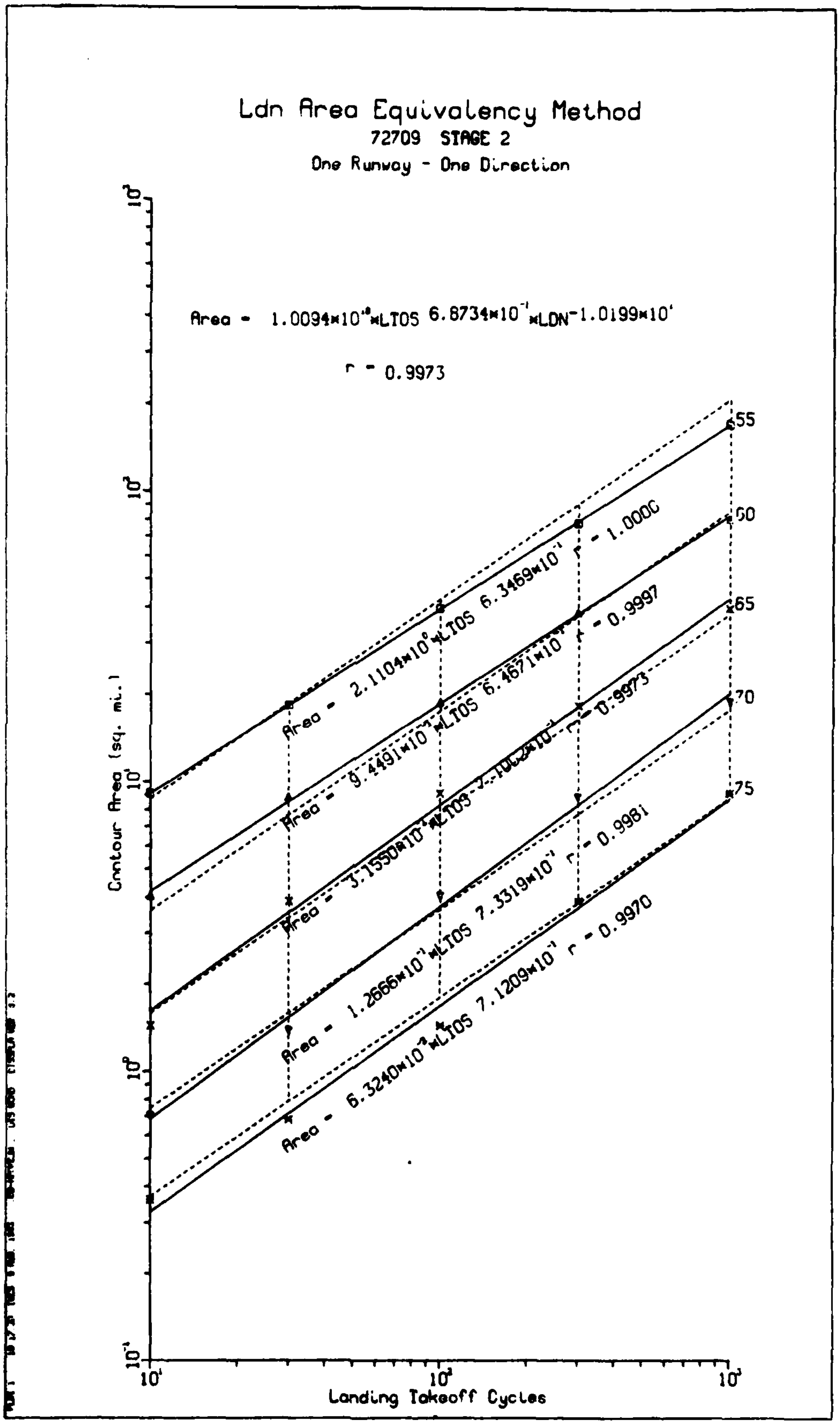


FIGURE 3-1. AEM LINEAR REGRESSION LINES FOR 727Q9 STAGE 2

## TABLE 3-1

## AEM PARAMETERS AND CORRELATION COEFFICIENTS FOR INM AIRCRAFT

(part 1 of 2)

| Aircraft Type | 65 Ldn a | 65 Ldn b | 65 Ldn r | 75 Ldn a | 75 Ldn b | 75 Ldn r |
|---|---|---|---|---|---|---|
| 747100 | .22594 | .70658 | .9999 | .058717 | .6568 | .9982 |
| 747200 | .094848 | .71062 | .9993 | .056022 | .52171 | .9811 |
| 74710Q | .085753 | .70686 | .9994 | .039767 | .56111 | .9922 |
| 747SP | .072382 | .70726 | .9987 | .031276 | .57653 | .9889 |
| DC820 | .54677 | .61749 | .9995 | .094781 | .67403 | .9994 |
| 707 | .43092 | .63363 | .9997 | .081632 | .6692 | .9999 |
| 720 | .30018 | .65145 | .9997 | .062408 | .66438 | .9997 |
| 707320 | .46628 | .63776 | .9996 | .086793 | .67387 | .9993 |
| 707120 | .39068 | .63666 | .9994 | .075951 | .66588 | .9976 |
| 720B | .33421 | .64428 | .9994 | .057873 | .68983 | .9993 |
| DC850 | .45335 | .6216 | .9994 | .085881 | .66095 | .9988 |
| DC860 | .50433 | .63693 | .9997 | .093926 | .67211 | .9992 |
| DC8CFM | .095168 | .56752 | .9995 | .058978 | .42531 | .9901 |
| 707CFM | .090267 | .56054 | .9976 | .075816 | .36805 | .9844 |
| 707QN | .39478 | .61722 | .9995 | .070882 | .66658 | .9988 |
| DC8QN | .46346 | .60835 | .9991 | .074511 | .68043 | .9983 |
| CONCRD | 6.7267 | .57708 | .9809 | .24387 | .92165 | .996 |
| DC1010 | .055833 | .74586 | .9981 | .057591 | .44377 | .969 |
| DC1030 | .072532 | .7207 | .9992 | .055537 | .48144 | .9765 |
| DC1040 | .069732 | .72171 | .9991 | .055983 | .47362 | .9736 |
| L1011 | .061686 | .74073 | .9984 | .059958 | .45116 | .9729 |
| L10115 | .070318 | .73216 | .9987 | .061885 | .46334 | .9727 |
| 727200 | .37045 | .66575 | .9994 | .063094 | .70508 | .9984 |
| 727100 | .31686 | .66503 | .999 | .050802 | .71719 | .9988 |
| 727D15 | .62462 | .55075 | .9906 | .081524 | .66068 | .9902 |
| 727Q9 | .39856 | .64771 | .9993 | .063155 | .70725 | .9985 |
| 727Q7 | .25431 | .67698 | .9987 | .041575 | .72221 | .9987 |
| 727Q15 | .63749 | .59125 | .9996 | .088996 | .69357 | .9974 |
| 727D17 | .77352 | .58384 | .9992 | .13183 | .65354 | .9965 |
| A300 | .056243 | .70843 | .9973 | .065947 | .40001 | .9676 |
| 767 | .045582 | .73509 | .9994 | .029423 | .51749 | .9843 |
| A310 | .049037 | .70737 | .9975 | .033022 | .4913 | .9897 |
| BAC111 | .15806 | .6387 | .9998 | .045305 | .60061 | .9996 |
| F28 | .11424 | .67717 | .9979 | .061902 | .51202 | .9969 |
| DC930 | .255 | .64224 | .9992 | .047022 | .67878 | .9992 |
| DC910 | .15256 | .68445 | .9994 | .028217 | .70457 | .9974 |
| 737 | .20892 | .67236 | .9977 | .032167 | .72995 | .9991 |
| DC9Q9 | .19709 | .65771 | .9971 | .034592 | .70398 | .9957 |
| DC9Q7 | .12141 | .69248 | .9992 | .023937 | .69715 | .9941 |
| 737QN | .17448 | .68081 | .9973 | .02582 | .7414 | .9974 |
| DC950 | .54058 | .58632 | .9992 | .084585 | .6713 | .9977 |
| 737D17 | .47652 | .58646 | .999 | .058649 | .7154 | .9983 |
| DC980 | .057292 | .7005 | .9989 | .029371 | .53347 | .985 |
| 757RB | .035748 | .78426 | .9998 | .028126 | .51577 | .9737 |

TABLE 3-1

AEM PARAMETERS AND CORRELATION COEFFICIENTS FOR INM AIRCRAFT

(part 2 of 2)

| Aircraft | 65 Ldn | | | 75 Ldn | | |
|---|---|---|---|---|---|---|
| Type | a | b | r | a | b | r |
| 757JT | .035748 | .78426 | .9998 | .028126 | .51577 | .9737 |
| COMJET | .28504 | .61027 | .9993 | .058735 | .64206 | .9995 |
| GALTF | .044167 | .62141 | .9993 | .030673 | .4399 | .9814 |
| GALTJ | .38843 | .60457 | .9996 | .061997 | .68055 | .999 |
| GAMTF | .052119 | .63153 | .9971 | .037255 | .43601 | .9889 |
| GALQTF | .022013 | .52699 | .9789 | .015311 | .3752 | .9882 |
| L188 | .016869 | .78133 | .9863 | .029594 | .37025 | .9639 |
| L100 | .033394 | .79478 | .9983 | .026474 | .51704 | .9815 |
| DHC7 | .011101 | .68707 | .9794 | .0073122 | .47978 | .9967 |
| CV580 | .020242 | .632 | .9712 | .025308 | .33308 | .9961 |
| HTETP | .026254 | .69683 | .9935 | .030705 | .39219 | .9764 |
| MTETP | .023894 | .51311 | .9644 | .020488 | .33031 | .9881 |
| DHC6 | .015311 | .4805 | .9796 | .0042779 | .51577 | .9779 |
| 4EP | .058605 | .81526 | .9993 | .033666 | .58784 | .9876 |
| TEP | .042943 | .75885 | .9969 | .034507 | .49549 | .9898 |
| COMTEP | .01671 | .49302 | .9749 | .004013 | .54427 | .9773 |
| COMSEP | .0096306 | .54076 | .9782 | .0026634 | .54335 | .9829 |
| KC135 | 2.7893 | .63015 | .998 | .45159 | .69334 | .9995 |
| C130 | .033394 | .79478 | .9983 | .026474 | .51704 | .9815 |
| F4 | 1.0301 | .66118 | .9999 | .23697 | .65296 | .9994 |
| A7D | .47499 | .6464 | .9996 | .11567 | .63347 | .9996 |
| CL600 | .049046 | .5045 | .9848 | .039268 | .33787 | .9976 |

## 4.0 VISICALC METHOD

The AEM doesn't require any programming experience. It does require VISICALC© and an Apple® II plus with 64K random access memory (RAM) or Apple IIe personal computer. VISICALC is a widely available electronic worksheet which combines the convenience of a calculator with the memory and screen control of a personal computer. In VISICALC parlance, AEM is a template called DNLAEM (Figure 4-1) which is stored on a 5-1/4 inch diskette. Appendix A provides instructions on how to obtain a copy of DNLAEM. When retrieved from the diskette the DNLAEM template becomes a worksheet to which you add aircraft identities and the associated landings and takeoffs (LTOs) in the appropriate columns (see Figure 4-2).

DNLAEM contains all the equations necessary to calculate an airport contour area from the list of aircraft types and LTOs. DNLAEM includes the a and b parameters for each of the 66 aircraft shown in Table 3-1. The following instructions should lead you to produce output reports similar to those examples in Figures 4-3 and 4-4. The keystrokes are given in **boldface** type. **RETURN** indicates the key labeled RETURN.

### 4.1 INSTRUCTIONS

| | Instruction | Comment |
|---|---|---|
| STEP 1. | Insert VISICALC diskette into disk drive #1 and close the door. | You must load VISICALC before each session. |
| STEP 2. | Turn on both the computer and the monitor. Wait for the standard VISICALC template to appear. | Turning on the computer "boots" the VISICALC diskette. |
| STEP 3. | Remove the VISICALC diskette and insert the AEM diskette into disk drive #1. | The VISICALC diskette is no longer needed for the duration of this session. |

| | Instruction | Comment |
|---|---|---|
| STEP 4. | Type **/SL**. | **/** shifts you into the command mode. **S** selects STORAGE. **L** indicates the desire to load a template. |
| STEP 5. | Hit the right arrow → until 'DNLAEM' appears on the edit line. | The right arrow "poles" through the diskette to find the AEM template. |
| STEP 6. | Hit **RETURN** . | The AEM template is being loaded. |
| STEP 7. | Wait for the cursor to appear in coordinate H5. If you are not in H5 type **>H5** and **RETURN.** | **>** invokes the GOTO command and H5 indicates the destination coordinate. |
| STEP 8. | Hit **"** (quote mark), enter title (up to 9 characters) and hit **RETURN.** | The **"** causes VISICALC to treat the entry as a label. |
| STEP 9. | Hit → . | The cursor moves to H6. |
| STEP 10. | Enter **1** or **2** and **RETURN** . | You are choosing between calculating 65 $L_{dn}$ ( 1 ) or 75 $L_{dn}$ ( 2 ) contour area. |
| STEP 11. | Type **>H11** and **RETURN** . | The cursor moves to the first coordinate under the column labeled 'Aircraft ID'. |
| STEP 12. | For each aircraft type enter corresponding ID and hit → | The cursor moves down the column as you enter each aircraft. Up to 20 allowed. |
| STEP 13. | Type **>I11** and **RETURN** . | The cursor moves to the first coordinate under the column labeled 'DAY'. |
| STEP 14. | For each aircraft type enter the corresponding LTOs during daytime and hit → . | Daytime includes the hours 7am to 10pm. The cursor moves down the column after each entry. |
| STEP 15. | Type **>J11** and **RETURN** . | The cursor moves to the first coordinate under the column labeled 'NIGHT'. |

| | Instruction | Comment |
|---|---|---|
| STEP 16. | For each aircraft type enter the LTOs which occur at night and hit →. | Night includes the hours 10pm to 7am. The cursor moves down the column after each entry. |
| STEP 17. | Type ! (exclamation point). | The cursor disappears and the computations have begun. Return of cursor signals end of calculations. |
| STEP 18. | Type **>R35** and **RETURN**. | |
| STEP 19. | If coordinate P34 contains 'NA' then type **>H5** and **RETURN**. Go back to STEP 7 and check your entries. | Something is wrong with your input. |
| STEP 20. | If coordinate R32 contains 'TRUE' then skip to STEP 29. | Your results are correct. You may now print them out. |
| STEP 21. | Write down value in R31. | Validity test is FALSE. |
| STEP 22. | Type **>N32** and **RETURN**. | N32 contains reference area. |
| STEP 23. | Enter a new reference contour area. | If value in R31 is greater than 1.02 then enter a number less than shown. Otherwise, enter a number greater than shown. |
| STEP 24. | Hit **RETURN** then **!**. | Recalculation starts. Await return of cursor. |
| STEP 25. | Type **>R35** and **RETURN**. | |
| STEP 26. | If R32 contains 'FALSE' then repeat steps 21 through 25 until R32 contains 'TRUE'. | |
| STEP 27. | Type **>N32** and **RETURN**. | |
| STEP 28. | Type **+N31** and **RETURN**. | The coordinate N32 is now returned to its original value. |
| STEP 29. | Write down contour area. | If you don't have a printer, you are done. |
| STEP 30. | Type **>H1** and **RETURN**. | |
| STEP 31. | Make sure printer is turned on and ready. On Apple IIe, make sure CAPS LOCK key is down. | |

| Instruction | Comment |
| --- | --- |
| STEP 32. Type **/PP"^EQ** and **RETURN** . | / shifts to command mode. **P** is PRINT command. **P** indicates printer. " invokes SETUP. **^EQ** is a special command to compress print type. This last command works with only certain kinds of printers. |
| STEP 33. Type **-R35** and **RETURN** . | The completed worksheet is being printed. The output is single spaced with H1 upper left corner and R35 lower right corner. |

The real utility of VISICALC comes from the fact that the worksheet is still available for you to change any of your entries and rerun. For example, let's say that you have just produced the 65 $L_{dn}$ contour area and you want to calculate the area within 75 $L_{dn}$. Simply go to coordinate H6 and enter a 2 and RETURN. Skip to STEP 17 and proceed. You can do the same thing with aircraft types or LTOs.

DNLAEM
Day Night Average Sound Level
Area Equivalent Method

________<<<Title (Hit " to start)
________<<<Level (1=65 or 2=75 Ldn)

NA Ldn

| Aircraft ID | LTO Cycles Day | Night | Weighted | Constants a | b | Aircraft Area | Energy | Wgtings | To Verify Area LTOs | Eff LTOs |
|---|---|---|---|---|---|---|---|---|---|---|
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| | | | | | | 0 | 0 | 0 | | 0 |
| Totals: | 0 | 0 | 0 | | | 0<Ref Area | | Validity Test: | | FALSE |

Contour Area = NA sq. mi.

FIGURE 4-1. DNLAEM, THE AEM VISICALC TEMPLATE

```
           DNLAEM
Day Night Average Sound Level
   Area Equivalent Method

_________<<<Title (Hit " to start)
_________<<<Level (1=65 or 2=75 LDN)


Aircraft           LTO Cycles  Aircraft  Aircraft  Aircraft  Aircraft
   ID        Day       Night       Type        ID      Type        ID
I_______II_______II_______I      747100         1       F28        34
I_______II_______II_______I      747200         2     DC930        35
I_______II_______II_______I      74710Q         3     DC910        36
I_______II_______II_______I       747SP         4       737        37
I_______II_______II_______I       DC820         5     DC9Q9        38
I_______II_______II_______I         707         6     DC9Q7        39
I_______II_______II_______I         720         7     737QN        40
I_______II_______II_______I      707320         8     DC950        41
I_______II_______II_______I      707120         9    737D17        42
I_______II_______II_______I        720B        10     DC980        43
I_______II_______II_______I       DC850        11     757RB        44
I_______II_______II_______I       DC860        12     757JT        45
I_______II_______II_______I      DC8CFM        13    COMJET        46
I_______II_______II_______I      707CFM        14     GALTF        47
I_______II_______II_______I       707QN        15     GALTJ        48
I_______II_______II_______I       DC8QN        16     GAMTF        49
I_______II_______II_______I      CONCRD        17    GALQTF        50
I_______II_______II_______I      DC1010        18      L188        51
I_______II_______II_______I      DC1030        19      L100        52
I_______II_______II_______I      DC1040        20      DHC7        53
                                  L1011        21     CV580        54
   Totals:           0         0 L10115        22     HTETP        55
                                 727200        23     MTETP        56
                                 727100        24      DHC6        57
                                 727D15        25       4EP        58
                                  727Q9        26       TEP        59
                                  727Q7        27    COMTEP        60
                                 727Q15        28    COMSEP        61
                                 727D17        29     KC135        62
                                   A300        30      C130        63
                                    767        31        F4        64
                                   A310        32       A7D        65
                                 BAC111        33     CL600        66
```

FIGURE 4-2. DNLAEM FILLIN FORMAT

DNLAEM
Day Night Average Sound Level
Area Equivalent Method

LONG BCH<<<Title (Hit " to start)
1<<<Level (1=65 or 2=75 Ldn)

65 Ldn

| Aircraft ID | LTO Cycles Day | Night | Weighted | Constants a | b | Aircraft Area | Energy | Wgtings | To Verify Area LTOs | Eff LTOs |
|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 3 | I______I | 3 | .39856 | .64771 | .8119512 | .5750402 | .8878050 | 9.076823 | .3305121 |
| 43 | 14 | I______I | 14 | .057292 | .7005 | .3638787 | .1906343 | .2721404 | 122.5498 | .1142392 |
| 46 | 10 | I______I | 10 | .28504 | .61027 | 1.161919 | 1 | 1.638619 | 17.99973 | .5555638 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| | | | | | | 1.161919 | 1.765674 | 2.798564 | | 1.000315 |
| Totals: | 27 | 0 | 27 | | | 1.161919<Ref Area | | Validity Test: | | TRUE |

Contour Area = 1.663248 sq. mi.

FIGURE 4-3. EXAMPLE OF AN AEM 65 LDN OUTPUT FROM VISICALC

DNLAEM
Day Night Average Sound Level
Area Equivalent Method

LONG BCH<<<Title (Hit " to start)
2<<<Level (1=65 or 2=75 Ldn)

75 Ldn

| Aircraft ID | LTO Cycles Day | Night | Weighted | Constants a | b | Aircraft Area | Energy | Wgtings | To Verify Area LTOs | Eff LTOs |
|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 3I | ______I | 3 | .063155 | .70725 | .1373573 | .4110069 | .5811338 | 11.46648 | .2616323 |
| 43 | 14I | ______I | 14 | .029371 | .53347 | .1200449 | .2389925 | .4479962 | 106.6107 | .1313189 |
| 46 | 10I | ______I | 10 | .058735 | .64206 | .2576066 | 1 | 1.557487 | 16.44653 | .6080311 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| I______I | I______I | I______I | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| | | | | | | .2576066 | 1.649999 | 2.586617 | | 1.000982 |
| Totals: | 27 | 0 | 27 | | | .2576066<Ref Area | | Validity Test: | | TRUE |

Contour Area = 0.35 sq. mi.

FIGURE 4-4. EXAMPLE OF AEM 75 LDN OUTPUT FROM VISICALC

## 5.0 CALCULATOR METHOD

In the event that an Apple II computer and VISICALC software are not available, your calculator and the worksheet in Figure 5-1 make good substitutes. With the following instructions, you perform the same tasks as accomplished by the AEM on VISICALC.

### 5.1 INSTRUCTIONS

STEP 1. Enter aircraft types in column 1.

STEP 2. Enter the daytime and nighttime LTOs for each aircraft type in columns 2 and 3.

STEP 3. Compute the effective LTOs of each aircraft in column 4 by multiplying the nighttime LTOs from column 3 by 10 and adding the daytime LTOs from column 2.

STEP 4. Enter in columns 5 and 6 the appropriate aircraft a and b parameters from Table 3-1.

STEP 5. Compute the area of each aircraft by applying the equation in the development section $A=aN^b$, where a is in column 5, b is in column 6, and N is the number of effective LTOs in column 4. Enter the area A, for each aircraft in column 7.

STEP 6. Select the largest area in column 7 and refer to this as the "reference area," $A_R$.

STEP 7. Calculate the energy contribution E for each aircraft. This is done by dividing the area of each aircraft by the reference area and raise the quotient to the power of the reciprocal of the b parameter (1/b). Enter the result in column 8.

STEP 8. Sum column 8 and enter the result in the box labeled $\overline{E}$.

STEP 9. Calculate the weighting factor W for each aircraft with the equation $W=E/b$. Divide the energy contribution E of each aircraft by the b parameter and enter the quotient in column 9.

STEP 10. Sum column 9 and enter the result in the box labeled $\overline{W}$.

STEP 11. Calculate the scaling parameter $\overline{b}$ for the aircraft mix by dividing $\overline{E}$ by $\overline{W}$. Enter the quotient in the box labeled $\overline{b}$.

STEP 12. Calculate the contour area of the aircraft mix by applying the energy contribution $\overline{E}$, the scaling parameter $\overline{b}$, and the reference area $A_R$ to the equation $\overline{A}=A_R(\overline{E^b})$. The result $\overline{A}$ is the DNL noise contour area of the specific aircraft mix.

STEP 13. Determine the number of LTOs that each aircraft must fly in order to have a noise contour area equal to that of the entire mix. Divide the DNL noise contour area of the entire mix $\overline{A}$ by the parameter a in column 5 and raise the quotient to the power of the reciprocal of the b parameter. Enter the result $\overline{N}$ in column 10.

STEP 14. Calculate the ratio of LTOs of each aircraft by dividing the effective LTOs in column 4 by $\overline{N}$ in column 10. Enter the result in column 11.

STEP 15. Sum column 11 and enter the result in the box labeled 'Validity Check'.

STEP 16. If the validity value is between 1.00 and 1.02 then the result is correct. You are done.

STEP 17. If the validity value is not between 1.00 and 1.02, return to STEP 1 and check all your figures.

STEP 18. If the validity check produces the same value, change the reference area according to the following:
- If the validity value is greater than 1.02, enter a reference area less than already present.
- If the validity value is less than 1.00, enter a reference area greater than already present.

STEP 19. Repeat the steps starting at STEP 7.

Day Night Average Sound Level
Area Equivalent Method

Calculator Method

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| Aircraft Type | Daytime LTOs | Nighttime LTOs | Effective LTOs | Constants a | b | Aircraft Area $A=aN^b$ | Energy $E=\left(\frac{A}{A_R}\right)^{\frac{1}{b}}$ | Weighting Factor $W=E/b$ | Verification # of LTOs $\bar{N}=\left(\frac{\bar{A}}{a}\right)^{\frac{1}{\bar{b}}}$ | Eff. LTOs $\frac{\text{Eff. LTOs} - \bar{N}}{\text{Eff. LTOs}}$ |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | Reference $A_R$ | Energy $\bar{E}$ | Weighting $\bar{W}$ | Validity Check | |
| | | | | | | $\bar{b}$: | $\bar{A}$: | Contour Area: | | |

FIGURE 5-1. AEM CALCULATOR METHOD WORKSHEET

## APPENDIX A

## AVAILABILITY OF AEM ON VISICALC

The AEM is available on a single sided, single density 5-1/4 inch diskette. The information on the diskette is compatible with the 16 *sector version of VISICALC® for Apple® II plus* with 64K RAM and Apple IIe personal computers. The cost to you is $10 for materials and services. To order AEM on VISICALC, fill out request form (p. A-2) and send with check or money order payable to the "United States Treasury" to:

Federal Aviation Administration
AEE-120
800 Independence Ave., S.W.
Washington, DC 20591
Attention: Thomas L. Connor

Appendix B contains a listing of the AEM template for VISICALC.

# AEM ON VISICALC REQUEST

I request a 5-1/4 inch diskette of the AEM.

NAME: ______________________________

TITLE: ______________________________

COMPANY: ______________________________

STREET ADDRESS: ______________________________

CITY, STATE ZIP: ______________________________

TELEPHONE NO.: ______________________________

APPENDIX B

AEM TEMPLATE LISTING

This appendix contains the keystrokes to create the DNLAEM template on VISICALC. Please refer to the VISICALC user manual for an explanation of the commands. Entry at a particular coordinate (or cell) is shown as the coordinate identification followed by a colon and then the appropriate keystrokes. Keystrokes which are shown without a coordinate identification always refer to the previously specified coordinate, usually on the line above. Table B-1 contains the locations (row and column) of the specific aircraft a and b parameters on the AEM template. Table B-2 provides the locations of the aircraft names and identifications.

```
/X!/X>A1:>H5:
/GC9
/GRM
/W1
A8 :  +H6
A11:  +H11
      /R
      A12.A30
      R
B10:  "a
B11:  @IF(A8<>2,@LOOKUP(A11,B47.B112),@LOOKUP(A11,F47.F112))
      /R
      B12.B30
      NRNNRNN
C10:  "b
C11:  @IF(A8<>2,@LOOKUP(A11,D47.D112),@LOOKUP(A11,H47.H112))
      /R
      C12.C30
      NRNNRNN
H2 :  "Day Night
H3 :  "   Area E
H5 :  "_________  (9 underline strokes)
H6 :  "
H9 :  /FL"Aircraft
H10:  /FL"   ID
H11:  "!_______!  (7 underline strokes between two exclamation points)
      /R
      H12.H30
      /R.H30
      I11.J11
H32:  /FR"Totals:
```

## AEM TEMPLATE LISTING (continued)

```
I1 :  /FG"  DNLAEM
I2 :  /FG" Average
I3 :  "quivalent
I5 :  /FG"<<<Title
I6 :  /FG"<<<Level
I9 :  "         L
I10:  /FL"   Day
I32:  @SUM(I11.I3Ø)
      /R
      J32.K32
      RR
J2 :  /FG"Sound Lev
J3 :  /FG" Method
J5 :  "(Hit " to
J6 :  /FG"(1=65 or
J9 :  "TO Cycles
J10:  /FL"  Night
K2 :  /FL"el
K5 :  /FG" start)
K6 :  /FG"2=75 Ldn)
K10:  "Weighted
K11:  +I11+(J11*1Ø)
      /R
      K12.K3Ø
      RR
L9 :  /FR"Cons
L10:  /FL"    a
L11:  @IF(@ISNA(B11),@NA,B11)
      /R
      L12.L3Ø
      RR
M7 :  @CHOOSE(H6,65,75)
M9 :  /FL"tants
M10:  /FL"    b
M11:  @IF(@ISNA(C11),@NA,C11)
      /R
      M12.M3Ø
      RR
N7 :  /FL" Ldn
N9 :  /FL"Aircraft
N10:  /FL"  Area
N11:  @IF(@ISNA(L11),Ø,+L11*(K11 M11))
      /R
      N12.N3Ø
      RRRR
N31:  @MAX(N11.N3Ø)
N32:  +N31
N34:  /FR"Contou
O10:  /FL"Energy
```

## AEM TEMPLATE LISTING

```
O11:  @IF(@OR(N32=Ø,@ISNA(M11)),Ø,(N11/N32) (1/M11))
      /R
      O12.O3Ø
      NRRNR
O32:  /FR"<Ref Area
O34:  /FL"r Area =
P10:  /FL"Wgtings
P11:  @IF(@ISNA(M11),Ø,O11/M11)
      /R
      P12.P3Ø
      RRR
O31:  @SUM(O11.O3Ø)
P31:  @SUM(P11.P3Ø)
P32:  /FR"Valid
P34:  /F$@IF(P31=Ø,@NA,+(O31 (O31/P31))*N31)
Q9 :  /FR"To Veri
Q10:  /FL"  LTOs
Q11:  @IF(@OR(@ISNA(L11),@ISNA(M11)),Ø,(P34/L11) (1/M11))
      /R
      Q12.Q30
      RRNRR
Q32:  /FL"ity Test:
Q34:  /FG"  sq. mi.
R9 :  /FL"fy Area
R10:  /FL"Eff LTOs
R11:  @IF(Q11=Ø,Ø,+K11/Q11)
      /R
      R12.R30
      RRR
R31:  @SUM(R11.R30)
R32:  @AND(R31>=1,R31<=1.Ø2)
```

TABLE B-1

LOCATIONS OF A AND B PARAMETERS ON AEM TEMPLATE
(part 1 of 2)

COLUMN

| | | | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 44 | ! | AIRCRAFT | AIRCRAFT | 65 LDN | AIRCRAFT | 65 LDN | AIRCRAFT | 75 LDN | AIRCRAFT | 75 LDN |
| | 45 | ! | TYPE | ID | A | ID | B | ID | A | ID | B |
| | 46 | ! | | | | | | | | | |
| | 47 | ! | 747100 | 1 | .22594 | 1 | .70658 | 1 | .058717 | 1 | .6568 |
| | 48 | ! | 747200 | 2 | .094848 | 2 | .71062 | 2 | .056022 | 2 | .52171 |
| | 49 | ! | 74710Q | 3 | .085753 | 3 | .70686 | 3 | .039767 | 3 | .56111 |
| | 50 | ! | 747SP | 4 | .072382 | 4 | .70726 | 4 | .031276 | 4 | .57653 |
| | 51 | ! | DC820 | 5 | .54677 | 5 | .61749 | 5 | .094781 | 5 | .67403 |
| | 52 | ! | 707 | 6 | .43092 | 6 | .63363 | 6 | .081632 | 6 | .6692 |
| | 53 | ! | 720 | 7 | .30018 | 7 | .65145 | 7 | .062408 | 7 | .66438 |
| | 54 | ! | 707320 | 8 | .46628 | 8 | .63776 | 8 | .086793 | 8 | .67387 |
| | 55 | ! | 707120 | 9 | .39068 | 9 | .63666 | 9 | .075951 | 9 | .66588 |
| | 56 | ! | 720B | 10 | .33421 | 10 | .64428 | 10 | .057873 | 10 | .68983 |
| | 57 | ! | DC850 | 11 | .45335 | 11 | .6216 | 11 | .085881 | 11 | .66095 |
| | 58 | ! | DC860 | 12 | .50433 | 12 | .63693 | 12 | .093926 | 12 | .67211 |
| | 59 | ! | DC8CFM | 13 | .095168 | 13 | .56752 | 13 | .058978 | 13 | .42531 |
| | 60 | ! | 707CFM | 14 | .090267 | 14 | .56054 | 14 | .075816 | 14 | .36805 |
| | 61 | ! | 707QN | 15 | .39478 | 15 | .61722 | 15 | .070882 | 15 | .66658 |
| | 62 | ! | DC8QN | 16 | .46346 | 16 | .60835 | 16 | .074511 | 16 | .68043 |
| R | 63 | ! | CONCRD | 17 | 6.7267 | 17 | .57708 | 17 | .24387 | 17 | .92165 |
| O | 64 | ! | DC1010 | 18 | .055833 | 18 | .74586 | 18 | .057591 | 18 | .44377 |
| W | 65 | ! | DC1030 | 19 | .072532 | 19 | .7207 | 19 | .055537 | 19 | .48144 |
| | 66 | ! | DC1040 | 20 | .069732 | 20 | .72171 | 20 | .055983 | 20 | .47362 |
| | 67 | ! | L1011 | 21 | .061686 | 21 | .74073 | 21 | .059958 | 21 | .45116 |
| | 68 | ! | L10115 | 22 | .070318 | 22 | .73216 | 22 | .061885 | 22 | .46334 |
| | 69 | ! | 727200 | 23 | .37045 | 23 | .66575 | 23 | .063094 | 23 | .70508 |
| | 70 | ! | 727100 | 24 | .31686 | 24 | .66503 | 24 | .050802 | 24 | .71719 |
| | 71 | ! | 727D15 | 25 | .62462 | 25 | .55075 | 25 | .081524 | 25 | .66068 |
| | 72 | ! | 727Q9 | 26 | .39856 | 26 | .64771 | 26 | .063155 | 26 | .70725 |
| | 73 | ! | 727Q7 | 27 | .25431 | 27 | .67698 | 27 | .041575 | 27 | .72221 |
| | 74 | ! | 727Q15 | 28 | .63749 | 28 | .59125 | 28 | .088996 | 28 | .69357 |
| | 75 | ! | 727D17 | 29 | .77352 | 29 | .58384 | 29 | .13183 | 29 | .65354 |
| | 76 | ! | A300 | 30 | .056243 | 30 | .70843 | 30 | .065947 | 30 | .40001 |
| | 77 | ! | 767 | 31 | .045582 | 31 | .73509 | 31 | .029423 | 31 | .51749 |
| | 78 | ! | A310 | 32 | .049037 | 32 | .70737 | 32 | .033022 | 32 | .4913 |
| | 79 | ! | BAC111 | 33 | .15806 | 33 | .6387 | 33 | .045305 | 33 | .60061 |
| | 80 | ! | F28 | 34 | .11424 | 34 | .67717 | 34 | .061902 | 34 | .51202 |
| | 81 | ! | DC930 | 35 | .255 | 35 | .64224 | 35 | .047022 | 35 | .67878 |
| | 82 | ! | DC910 | 36 | .15256 | 36 | .68445 | 36 | .028217 | 36 | .70457 |
| | 83 | ! | 737 | 37 | .20892 | 37 | .67236 | 37 | .032167 | 37 | .72995 |
| | 84 | ! | DC9Q9 | 38 | .19709 | 38 | .65771 | 38 | .034592 | 38 | .70398 |
| | 85 | ! | DC9Q7 | 39 | .12141 | 39 | .69248 | 39 | .023937 | 39 | .69715 |
| | 86 | ! | 737QN | 40 | .17448 | 40 | .68081 | 40 | .02582 | 40 | .7414 |
| | 87 | ! | DC950 | 41 | .54058 | 41 | .58632 | 41 | .084585 | 41 | .6713 |
| | 88 | ! | 737D17 | 42 | .47652 | 42 | .58646 | 42 | .058649 | 42 | .7154 |
| | 89 | ! | DC980 | 43 | .057292 | 43 | .7005 | 43 | .029371 | 43 | .53347 |
| | 90 | ! | 757RB | 44 | .035748 | 44 | .78426 | 44 | .028126 | 44 | .51577 |

TABLE B-1

LOCATIONS OF A AND B PARAMETERS ON AEM TEMPLATE

(part 2 of 2)

| | | COLUMN | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | H | I |
| | 91 | 757JT | 45 | .035740 | 45 | .70426 | 45 | .028126 | 45 | .51577 |
| | 92 | CONJET | 46 | .20504 | 46 | .61027 | 46 | .058735 | 46 | .64206 |
| | 93 | BALTF | 47 | .044167 | 47 | .62141 | 47 | .030673 | 47 | .4399 |
| | 94 | BALTJ | 48 | .30043 | 48 | .60457 | 48 | .061997 | 48 | .68055 |
| | 95 | BANTF | 49 | .052119 | 49 | .63153 | 49 | .037255 | 49 | .43601 |
| | 96 | BAL8TF | 50 | .022013 | 50 | .52699 | 50 | .015311 | 50 | .3752 |
| | 97 | L100 | 51 | .016849 | 51 | .78133 | 51 | .029594 | 51 | .37025 |
| | 98 | L100 | 52 | .033394 | 52 | .79478 | 52 | .026474 | 52 | .51704 |
| | 99 | DHC7 | 53 | .011101 | 53 | .68707 | 53 | .0073122 | 53 | .47978 |
| R | 100 | CV580 | 54 | .020242 | 54 | .632 | 54 | .025308 | 54 | .33308 |
| O | 101 | MTETP | 55 | .026254 | 55 | .69683 | 55 | .030705 | 55 | .39219 |
| W | 102 | MTETP | 56 | .023894 | 56 | .51311 | 56 | .020488 | 56 | .33031 |
| | 103 | DHC6 | 57 | .015311 | 57 | .4805 | 57 | .0042779 | 57 | .51577 |
| | 104 | 4EP | 58 | .058605 | 58 | .81526 | 58 | .033666 | 58 | .58784 |
| | 105 | TEP | 59 | .042943 | 59 | .75885 | 59 | .034507 | 59 | .49549 |
| | 106 | COMTEP | 60 | .01671 | 60 | .49302 | 60 | .004013 | 60 | .54427 |
| | 107 | COMSEP | 61 | .0096306 | 61 | .54076 | 61 | .0026634 | 61 | .54335 |
| | 108 | KC135 | 62 | 2.7893 | 62 | .63015 | 62 | .45159 | 62 | .69334 |
| | 109 | C130 | 63 | .033394 | 63 | .79478 | 63 | .026474 | 63 | .51704 |
| | 110 | F4 | 64 | 1.0301 | 64 | .66118 | 64 | .23697 | 64 | .65296 |
| | 111 | A7D | 65 | .47499 | 65 | .6464 | 65 | .11567 | 65 | .63347 |
| | 112 | CL600 | 66 | .049046 | 66 | .5045 | 66 | .039268 | 66 | .33787 |

TABLE B-2

LOCATIONS OF AIRCRAFT NAMES AND IDENTITIES ON AEM TEMPLATE

| ROW | | COLUMN S | COLUMN T | COLUMN U | COLUMN V |
|---|---|---|---|---|---|
| | 9 | Aircraft | Aircraft | Aircraft | Aircraft |
| | 10 | Type | ID | Type | ID |
| | 11 | 747100 | 1 | F28 | 34 |
| | 12 | 747200 | 2 | DC930 | 35 |
| | 13 | 74710Q | 3 | DC910 | 36 |
| | 14 | 747SP | 4 | 737 | 37 |
| | 15 | DC820 | 5 | DC9Q9 | 38 |
| | 16 | 707 | 6 | DC9Q7 | 39 |
| | 17 | 720 | 7 | 737QN | 40 |
| | 18 | 707320 | 8 | DC950 | 41 |
| | 19 | 707120 | 9 | 737D17 | 42 |
| | 20 | 720B | 10 | DC980 | 43 |
| | 21 | DC850 | 11 | 757RB | 44 |
| | 22 | DC860 | 12 | 757JT | 45 |
| | 23 | DC8CFM | 13 | COMJET | 46 |
| | 24 | 707CFM | 14 | GALTF | 47 |
| R | 25 | 707QN | 15 | GALTJ | 48 |
| O | 26 | DC8QN | 16 | GAMTF | 49 |
| W | 27 | CONCRD | 17 | GALQTF | 50 |
| | 28 | DC1010 | 18 | L188 | 51 |
| | 29 | DC1030 | 19 | L100 | 52 |
| | 30 | DC1040 | 20 | DHC7 | 53 |
| | 31 | L1011 | 21 | CV580 | 54 |
| | 32 | L10115 | 22 | HTETP | 55 |
| | 33 | 727200 | 23 | MTETP | 56 |
| | 34 | 727100 | 24 | DHC6 | 57 |
| | 35 | 727D15 | 25 | 4EP | 58 |
| | 36 | 727Q9 | 26 | TEP | 59 |
| | 37 | 727Q7 | 27 | COMTEP | 60 |
| | 38 | 727Q15 | 28 | COMSEP | 61 |
| | 39 | 727D17 | 29 | KC135 | 62 |
| | 40 | A300 | 30 | C130 | 63 |
| | 41 | 767 | 31 | F4 | 64 |
| | 42 | A310 | 32 | A7D | 65 |
| | 43 | BAC111 | 33 | CL600 | 66 |

## APPENDIX C

## REFERENCES


1. Civil Aeronautics Board, "Area Equivalent Method," February 1982.

2. Flythe, M. C., "INM Integrated Noise Model, Version 3 User's Guide," FAA-EE-81-17, October 1982.